

ART. IV.—*Suggestions for the Construction and Erection
of Lightning Conductors.*

By R. L. J. ELLERY, ESQ.

[Read 15th September, 1873.]

A building constructed entirely of metal without joints, except such as be metallically made, as by soldering, brazing, &c., and being in full contact with the earth, would be safe from the injurious effects of lightning.

A building of brick, stone, wood, or other imperfectly conducting material, will be well protected, if *caged over* by a network or grating of metal wire or rod, all metallically soldered into one continuous system, having projecting above it at one or more places, metal rods forming part of the same system, and having sharp bright points at their upper projecting ends, and if the lower portion of the cage-work be well connected with the earth.

The first condition would be secured in the case of a ship built, rigging and all, of iron, or by a building covered with lead, zinc, or iron, in which all the joints are soldered, and where the metal is continued downwards on all sides, so as to be well buried in the earth. The second condition, by placing over a building a frame-work of iron rod, or wire, so as to have no high or otherwise projecting part of the stone or brick building, above or outside the metallic framework, and having the framework projecting downwards into the earth at as many points as possible.

In ordinary buildings, however, it will be generally found more convenient and economical, and almost as effective, to adopt a modification of these arrangements.

The very essence of a lightning conductor is to afford an easy and wide way for the electricity to reach the earth, for it is only when such way is not present that mischief is done. A thoroughly good and extensive connection with the earth should be the first consideration, for without it all lightning-conductors rather add to than diminish the danger.

The surface of the earth, if dry, is a bad conductor; so that a permanently moist stratum is the only one that forms a good earth connection. The sea, a permanent river or creek, a lake, reservoir, or deep well, will all form good earth connections; all water, or gas-mains UNDER GROUND, are also equally good earth connectors, and *perfectly safe*.

In absence of such earth connections the conductor should terminate in a large plate or coil of wire buried sufficiently deep in a permanently moist stratum, and will be best if surrounded by coke or charcoal, which are absolutely imperishable materials of relatively high conductivity, and therefore well-suited for distributing the electrical discharge. There should be several of such earth plates, even to one conductor, which can be arranged by joining two or three such connectors to the conductor before entering the earth.

To summarise this part of the subject it may be laid down that "*A good and extensive earth connection is of paramount importance.*"

From the earth to the higher parts of the building the conductor may assume almost any form of a *continuous* metallic path. Iron rod, wire rope, sheet metal, pipes, or anything of the kind so long as it be large enough and metallically continuous ; mere contact of one piece of pipe or rod with another is dangerous—*they must be joined by solder* ; thus down pipes and ridging metal may be quite safe to use if *every joint is soldered over a large surface : no lapping*, however extensive, will do. Whatever be used must take the form of a continuous metal connection with the earth.

It is unnecessary, and in fact wrong, to insulate the conductor from any part of the building at all ; it should lay on the roof, along the gutters, or anywhere convenient, and pass down the walls at any convenient place, and be kept in position by any ordinary hold-fasts.

The upper projecting-rod of a lightning-conductor need never be more than three to five feet above the highest portion of the building to be protected, and should terminate in a single point, which it is better to make of a metal not liable to rust, and as most projectives of conductors will be of iron, a *good copper point, stoutly gilt*, well brazed to the iron, will be found the most economical and effective.

From experiments conducted by the French Academy of Sciences it is considered that the area protected by a single lightning conductor is about equal to twice the radius of its height ; therefore, if a conductor were a hundred feet high, it would protect a building covering an area of 100 feet radius ; but half this is now generally taken as the safest proportion, and, therefore, a conductor 100 feet high would protect a building of fifty feet radius. The lower the conductor the less area it will protect, so that a low straggling

building will require more projecting *points* than a tall one like a church with a spire.

Materials.—Any metal can be used, but lead and zinc being worse conductors than copper and iron, a larger surface of the former than the latter would be necessary. The form may be in rod wire, sheet, or tube, as most convenient. No less surface than is presented by wire quarter of inch thick should be used for copper or iron, and at least ten times that for zinc or lead.

Lead or metal ridging and guttering may be used if soldered at the joints; but as it is not safe to solder the laps themselves, as they would tear by expansion and contraction, a method similar to that suggested in the report of the French Academy for connecting iron framework in lightning conductors should be adopted, namely, at each joint a strip of copper to *form a bridge over it*, should be soldered, so that the bridge of metal will always give and take in the sliding of the lap due to expansion and contraction.

Down-pipes for conveying rain-water from the roof may also be used, if a similar device with regard to joints be adopted, and if a good plan for metallically connecting the guttering with the head of the pipe, and the foot of the pipe with the earth, be devised.

In most modern buildings the metal used on the roofs can be made to form a very effective portion of the system of a lightning conductor, by keeping in mind the foregoing suggestions, and all the ridging, guttering, &c., will in reality form a portion of a metallic cage protecting the roof.

Whether such metallic parts of the building form part of the true conductor or not, it will always be safest to connect all those parts *together and with the conductor*.

To put the foregoing into a more practical form, let the case of a church, with a spire 120 feet high, and a roof 100 feet long, be taken; the spire may have a *terminal* and weather vane of iron, or of wood sheathed in copper; then from the terminal below the vane, a copper or iron rod should spring to a little above the vane, terminating in the gilded copper point as already described; then from the base of the pinnacle, well soldered copper or iron rod, strip, tube or rope, take it down outside the spire to the metal ridge of the roof, to which it should be soldered in passing; carry it down to the earth, connecting by solder any metal guttering that it may come near on the way, and

take immediately to earth by one of the methods pointed out ; and if in a tower, this will best be done by connecting it with the underground water-mains ; but not to any portion of the pipes above ground or in the building.

The ridge metal should be connected by bridge strips, and another conductor at the end of the roof farthest from the spire should be erected and taken straight to earth, soldering to the ridge in passing. An arrangement of this kind will form an effective lightning conductor to such a building. If there be other towers or turrets more than 60 ft. or 70 ft. from the chief spire, each should have a small conductor.

In a building without a lofty tower or spire, and where chimney-stacks or gables form the highest points, the conductors should always be placed on the highest and most prominent parts, bearing in mind the proportion between height and area covered by the building, and it will thus often be found that even three, four, or more conductors will be necessary. Let them be fixed to the stacks by holdfasts ; soldered to ridges and gutters in passing ; taken over the roof OUTSIDE the walls, *each conductor* direct to earth. All the conductors must be connected into one system on the roof, by soldering some of the lines of ridging by bridges ; and the more of the roof metal brought into the system the better.

Iron rod, of from three-eighths to half an inch diameter, or tube three-quarters diameter, three-quarter inch copper tube, or strips of stout sheet copper two or three inches broad, or galvanized iron rope from half an inch diameter upwards will perhaps be found the most useful materials ; but in case of iron tube, *screwing without soldering* will be insufficient. Copper or iron rope, from its flexibility, will be found very useful ; but every joint must be covered with a good mass of solder. In reference to the use of wire rope, it is to be borne in mind that several strands of metal arranged in the form of a rope are liable to more rapid oxidation and decay than equivalent more compact forms of rod or tube ; whatever forms be adopted this element of decay should always be taken *account of, examining the continuity of the conductor* from time to time. When from any cause a breach of metallic continuity comes about, the building becomes less secure than it would be if such disordered lightning conductors were absent. The use of down-pipes to save the expense of bringing a special conductor to earth cannot be strongly recommended unless they

are in one piece, and go directly deep into the earth, as the making and keeping up good sound metallic joints will be found a difficulty in practice.

An independent conductor carried as direct to the earth as possible will be found the least expensive in the long run. Never take the conductors inside the buildings for the sake of *short cuts*, or for any reason except where a more rapid and extensive earth connection can be obtained by doing so, than otherwise.

Lightning conductors, as commonly arranged, are in most cases very far from ornamental additions to the buildings which they protect ; the use of vanes, pinnacles, ridging, and other external metallic details of a building to form portion of the conducting system has the recommendation of being less objectionable in an æsthetical sense than the form of lightning-rods wholly extrinsic to the design, as commonly employed ; and, by a little judicious management the ornamental terminations of gables, roof, towers, and turrets, may be made to entirely and very effectually subserve the requirements of a lightning protector by keeping in view the foregoing suggestions.

ART. V.—*Contaminated Water Supply.* By S. W. GIBBONS.

[Read 13th October, 1873.]

ART. VI.—*Eckhold's Omnimeter.* By R. L. J. ELLERY.

[Read 13th October, 1873.]

ART. VII.—*On the Occurrence of a species of Retepora (allied to R. phænicaea, Busk), in the tertiary beds of Schnapper Point, Hobson's Bay.*

By R. ETHERIDGE, Jun., F.G.S.,

(Of the late Geological Survey of Victoria).

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When examining for Foraminifera, portions of the light grey mud from the Eocene or Oligocene beds of Schnapper Point, the accidental fracture of a large mass revealed